REMARKS

The claims now pending in the application are Claims 1 to 17, the independent claims being Claims 1, 9 and 17. Claims 1 to 10, 13, 14, 16 and 17 have been amended herein.

In the Official Action dated August 29, 2003,-the title was objected to on formal grounds. Claims 1, 3, 5, 6, 9, 11, 13, 14 and 17 were rejected under 35 U.S.C. § 102(b), as anticipated by U.S. Patent No. 5,608,703 (Washisu), Claims 2 and 10 were rejected under 35 U.S.C. § 103(a), as unpatentable over the Washisu '703 patent in view of U.S. Patent No. 6,072,525 (Kaneda) and Claims 7, 8, 15 and 16 were rejected under 35 U.S.C. § 103(a), as unpatentable over the Washisu '703 patent in view of U.S. Patent No. 6,348,948 (Kyuma). Reconsideration and withdrawal of the objection and rejections respectfully are requested in view of the above amendments and the following remarks.

Initially, Applicant gratefully acknowledges the Examiner's indication that the application contains allowable subject matter, and that Claims 4 and 12 are allowable over the prior art.

In formal matters, the title has been amended more clearly to describe the claimed invention, as requested by the Examiner.

The specification and abstract of the disclosure have been amended to improve their form, including English spelling, grammar, idiom, syntax and the like. A substitute specification, together with a marked-up copy to indicate the proposed amendments, are submitted herewith.. No new matter has been added.

The rejections of the claims over the cited art respectfully are traversed. Nevertheless, without conceding the propriety of the rejections, Claims 1 to 10, 13, 14, 16 and 17 have been amended herein more clearly to recite various novel features of the present invention.

Independent Claim 1 as currently amended is directed to image sensing apparatus in which a noise reduction device reduces noise added to a sensed image by an internal apparatus factor utilizing correlation of sensed images. A zoom controller controls a zoom

magnification factor of the image sensing apparatus and a determination device determines whether the zoom controller is executing a zoom operation. A setting device sets a control value for time correlation in the noise reduction device according to a determination of the determination device.

Independent Claim 9 as currently amended is directed to an image sensing method for an image sensing apparatus. According to the method, noise added to a sensed image by an internal apparatus factor is reduced utilizing time correlation of sensed images. The zoom magnification factor of the image sensing apparatus is controlled and it is determined whether a zoom operation is being executed in the zoom control. A control value for time correlation in the noise reduction is set in accordance with the determination.

Independent Claim 17 as currently amended is directed to a storage medium that stores a program for executing an image sensing method for an image sensing apparatus. According to the method, noise added to a sensed image by an internal apparatus factor is reduced utilizing time correlation of sensed images. The zoom magnification factor of the image sensing apparatus is controlled and it is determined whether a zoom operation is being executed in the zoom control. A control value for time correlation in the noise reduction is set in accordance with the determination.

Each of independent Claims 1, 9 and 17 has been amended to recite more clearly the features wherein noise added to a sensed image by an internal factor of the image sensing apparatus is reduced utilizing time correlation of sensed images, and a control value for time correlation in the noise reduction is set in accordance with a determination whether a zoom operation is being executed. As discussed in the present application, the internal factor may be high density mounting of small components, high speed digitalization, high speed signal processing, high speed component control and the like (see, e.g., page 3, lines 14 to 20). Support for the proposed amendments may be found in the original application. No new matter has been added.

Applicant submits that the prior art fails to anticipate the present invention. Moreover, Applicant submits that there are differences between the subject matter sought to be patented and the prior art, such that the subject matter taken as a whole would not have been obvious to one of ordinary skill in the art at the time the invention was made.

The Washisu '703 patent relates to an image blur prevention apparatus, and discloses an apparatus and method in which image blur caused by vibration of a camera during image pickup is corrected by detecting a vibration causing the image blur and driving a correction optical system in first or second modes to correct the image blur. However, Applicant submits that the Washisu '703 patent fails to disclose or suggest at least the above-disclosed features of the present invention. Rather, the Washisu '703 patent is directed to correcting nosie (image blur) caused by an external factor of the camera. Nowhere does the Washisu '703 patent disclose or suggest the features of reducing nosie added to a sensed image by an internal factor of an image sensing apparatus utilizing time correlation of sensed images, let alone setting a control value for time correlation in the noise reduction in accordance with a determination of whether a zoom operation is being performed, as disclosed and claimed in the present application.

The Kaneda '525 patent relates to an image pickup apparatus effecting object image tracking responsively to object image frame movement and object image movement, and was for its alleged teachings regarding a relation between zoom magnification and camera shake. Without conceding the propriety of the Examiner's characterizations of the Kaneda '525 patent, Applicant submits that the Kaneda '525 patent fails to disclose or suggest at least the above-discussed features of the present invention. Nowhere does the Kaneda '525 patent disclose or suggest the features of reducing noise added to a sensed image by an internal factor of the apparatus utilizing time correlation of sensed images, let alone setting a control value for time correlation in the noise reduction in accordance with a determination of whether a zoom operation is being performed, as disclosed and claimed in the present application. Nor is the

Kaneda '525 patent understood to add anything to the Washisu '703 patent that would make obvious the claimed invention.

The Kyuma '948 patent relates to an interchangeable lens type camera system, and was cited for its disclosure of a camera utilizing optical zoom and electronic zoom in combination. Nevertheless, Applicant submits that the Kyuma '948 patent fails to disclose or suggest the above-discussed features of the present invention. Nowhere does the Kyuma '948 patent disclose or suggest the features of reducing noise added to a sensed image by an internal factor of the apparatus utilizing time correlation of sensed images, let alone setting a control value for time correlation in the noise reduction in accordance with a determination of whether a zoom operation is being performed, as disclosed and claimed in the present application. Nor is the Kyuma '948 patent believed to add anything to the Washisu '948 patent and/or the Kaneda '525 patent that would make obvious the claimed invention.

For the above reasons, Applicants submit that independent Claims 1, 9 and 17 are allowable over the cited art.

Claims 2 to 8 and 10 to 16 depend from Claims 1 and 9, respectively, and are believed allowable for the same reasons. Moreover, each of these dependent claims recites additional features in combination with the features of independent Claims 1 and 9, and is believed allowable in its own right. Individual consideration of the dependent claims respectfully is requested.

Applicant believes that the present Amendment is responsive to each of the points raised by the Examiner in the Official Action, and submits that the application is in allowable form. Favorable consideration of the claims and passage to issue of the present application at the Examiner's earliest convenience earnestly are solicited.

Applicant's attorney, C. Phillip Wrist, may be reached in our Washington, D.C. office by telephone at (202) 530-1010. All correspondence should continue to be directed to our below listed address.

Respectfully submitted,

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(Substitute Specification of Application No. 09/487,868 Marked-up Version)

IMAGE SENSING APPARATUS HAVING VARIABLE NOISE REDUCTION CONTROL BASED ON ZOOM OPERATION MODE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an image sensing apparatus having a noise reduction circuit, and to a control method for such an image sensing apparatus. The present invention also relates to a storage medium storing a program for sensing an image of an object, which program is executed by a CPU of an ~~the~~ image sensing apparatus.

Related Background Art

A conventional video camera has a noise reduction circuit for removing noise ~~noises~~ from a video signal. Noise reduction circuits, as well as various other video signal processing circuits, are now made of digital components along with the advent of digital video (DV) cassettes (SD format) and the like.

A cyclic type signal processing circuit, using a field memory, is generally used for a digital noise reduction circuit. As the price of ~~a~~ memory is declining with time, ~~lowers nowadays, the~~ digital noise reduction circuits ~~circuit is used~~ also are being used for general video cameras in ~~of~~ home use.

A cyclic type noise reduction circuit will be described which removes noise ~~noises by~~ using field images having a correlation in time. As shown in Fig. 3, a cyclic noise reduction

circuit has an input terminal 51, an adder 52, a subtractor 53, a multiplier 54, a field memory 55, a limiter 56 and an output terminal 57.

A signal Si input at ~~from~~ the input terminal 51 is supplied to the adder 52 and subtractor 53. The subtractor 53 subtracts the signal Si from a signal Sf, where Sf is a delayed signal output by the field memory 55, to thereby detect a noise signal Sn1 between fields. The detected signal Sn1 output by the subtractor 53 is supplied to the limiter 56.

Motion components contained in the signal Sn1 are eliminated by the limiter 56, which outputs a signal Sn2. This signal Sn2 is multiplied by an externally supplied coefficient K (hereinafter called a cyclic coefficient) by the multiplier. This signal K·Sn2 is supplied to the adder 52.

The adder 52 adds the signal Si to the signal K·Sn2 to remove noise components from the signal Si. A signal So output from the adder 52 is supplied to the field memory 55 and also is output from the output terminal 57.

For ~~the~~ simplification of description, it is assumed that Sn1 = Sn2 = Sn. The signal Sn is therefore given by the following equation ~~(1)~~:

$$Sn = Sf - Si \qquad \ldots (1)$$

The signal So is given by the following equation ~~(2)~~:

$$So = Si + K \cdot Sn$$

$$= Si + K \cdot (Sf - Si)$$

$$= (1 - K) \cdot Si + K \cdot Sf \qquad \ldots (2)$$

As seen from the equation (2), a ~~the~~ signal So having less noise components can be obtained as follows ~~in the following~~. Since the signal Si contains noise components and the signal Sf is a delayed signal corresponding to ~~of~~ the signal So, from which noise components have been ~~are~~ eliminated, the noise components become smaller ~~the more~~ as the cyclic

coefficient K approaches ~~is made as near as~~ the value 1. If the cyclic coefficient K is set to 0, the signal Si ~~itself~~ becomes the signal So.

The more effectively the noise components can be removed, the more the cyclic coefficient K can be ~~is~~ made to approach ~~as near as~~ the value 1. A video signal generated by a video camera is more likely to be affected by noise ~~noises~~, because of high density mounting ~~mount~~ of small components, high speed digitalization, high speed signal processing, and high speed component control. In order to avoid this, it is required to set the amount of noise reduction larger.

However, if the amount of noise reduction is made larger, although the noise reduction effect is improved, influence of a preceding field upon a current field becomes larger ~~large~~. Therefore, a latent image of a scene having a moving object becomes conspicuous.

This problem also occurs when a zoom operation is performed because the size of an object changes between successive fields even if the object does not move.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an image sensing apparatus capable of sensing an image of an object always in good condition ~~conditions~~ by realizing an optimum noise reduction process even under various photographing conditions and even with various functions of the apparatus, a control method for the apparatus, and a storage medium storing a program for realizing such a function.

In order to achieve the above objects ~~object~~ of the present invention, according to one aspect of the invention, there is provided an image sensing apparatus which comprises: noise reduction means for reducing noise ~~noises~~ of a sensed image ~~by~~ utilizing images having a

correlation in time; zoom control means for controlling a zoom magnification factor of the image sensing apparatus; judging means for judging whether the zoom control means is executing a zoom operation; and setting means for setting a control value for the noise reduction means in accordance with a judgment result by the judging means.

According to another aspect of the invention, there is provided an image sensing method which comprises the steps of: reducing noise ~~noises~~ of an image ~~a~~ sensed by an ~~image by~~ image sensing apparatus utilizing images having a correlation in time; controlling a zoom magnification factor of the image sensing apparatus; judging whether the zoom control step is executing a zoom operation; and setting a control value for the noise reduction step in accordance with a judgment result of ~~at~~ the judging step.

In ~~According to~~ another aspect, ~~of~~ the present invention relates to~~, there is provided~~ a storage medium storing a program for executing an image sensing method which comprises the steps of: reducing noise ~~noises~~ of an ~~a sensed~~ image sensed by an image sensing apparatus utilizing images having a correlation in time; controlling a zoom magnification factor of the image sensing apparatus; judging whether the zoom control step is executing a zoom operation; and setting a control value for the noise reduction step in accordance with a judgment result of ~~at~~ the judging step.

Other objects and advantages of the present invention will become apparent from the following detailed description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing the structure of an image sensing apparatus according to one ~~an~~ embodiment.

Fig. 2 is a block diagram showing the structure of a system control unit.

Fig. 3 is a block diagram showing the structure of a cyclic type noise reduction circuit.

Fig. 4 is a flow chart illustrating the sequence of a noise reduction control process.

Fig. 5 is a flow chart illustrating the sequence of a noise reduction control process to be followed by the flow chart shown in Fig. 4.

Fig. 6 is a graph showing the relation between the brightness of an object and the value of a cyclic coefficient K in a zoom step mode and in a zoom operation mode.

Fig. 7 is a graph showing the relation between the brightness of an object and the value of a cyclic coefficient K in the zoom stop mode and zoom operation mode, and at Steps 1 and 2.

Fig. 8 is a memory map of a ROM as a storage medium.

Fig. 9 is a block diagram showing the structure of an image sensing apparatus according to another embodiment.

Fig. 10 is a flow chart illustrating the sequence of a noise reduction control process.

Fig. 11 is a flow chart illustrating the sequence of a noise reduction control process to be followed by the flow chart shown in Fig. 10.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of an image sensing apparatus, a control method therefor and a storage medium according to the present invention will be described. Fig. 1 is a block diagram showing the structure of an image sensing apparatus. In Fig. 1, reference numeral 11 represents a zoom lens for focusing the image of an object, reference numeral 12 represents a diaphragm for adjusting a light quantity, reference numeral 13 represents an image pickup device made of a CCD for converting input light into an electric signal, and reference numeral 14 represents a sample/hold AGC circuit for sample/hold and gain adjustment.

Reference numeral 15 represents an analog-digital (A/D) converter unit for A/D conversion, and reference numeral 16 represents a video signal processing unit for processing a signal and generating a video signal. Reference numeral 17 represents an electronic zoom unit having a field memory for image cut and paste, magnification, and interpolation. Reference numeral 18 represents a noise reduction (NR) unit having a field memory for reducing noise ~~noises~~ from a video signal. Reference numeral 19 represents a lens position detection unit for detecting the position of the zoom lens 11, and reference numeral 20 represents a lens drive unit for driving the zoom lens 11.

Reference numeral 21 represents a system control unit for controlling the entirety of the image sensing apparatus. Fig. 2 is a block diagram showing the structure of the system control unit 21. The system control unit 21 has a CPU 31, a ROM 32, a RAM 33 and an I/O interface 34 which are well known in the art. ROM 32 stores programs and table values to be described later, the programs being executed by CPU 31.

Referring again to Fig. 1, reference ~~Reference~~ numeral 22 represents a zoom operation key unit having keys for zoom operations. Reference numeral 23 represents a ~~wide~~ wide-angle zoom key for moving the zoom lens in a ~~wide~~ wide-angle (wide = image reduction) zoom direction, and reference numeral 24 represents a telephoto zoom key for moving the zoom lens in a telephoto (telephoto = image magnification) zoom direction. In the present ~~For~~ example, the ~~wide~~ wide-angle zoom key 23 and telephoto zoom key 24 are keys of a see-saw type moving together. Each key outputs a signal representative of a depression pressure to the system control unit 21. The noise reduction (NR) unit 18 is made of a conventional cyclic type noise reduction circuit. Fig. 3 shows the structure of a cyclic type noise reduction circuit. The noise reduction circuit has an ~~the~~ input terminal 51, an adder 52, a subtractor 53,

a multiplier 54, a field memory 55, a limiter 56 and an output terminal 57. The operation of the cyclic type noise reduction circuit has been described in connection with the related art.

Light from an object received by the zoom lens 11 is adjusted in amount by the diaphragm 12 and focused on the surface of the image pickup device 13. After the light is converted into an electric signal by the image pickup device 13, the electric signal is supplied to the sample/hold AGC unit 14, A/D converted by the A/D converter unit 15, and input to the video signal processing unit 16.

The video signal processing unit 16 performs aperture correction, gamma correction, white balance correction and the like for each brightness and color component of an input signal, thereby to ~~to thereby~~ generate a video signal which is output to the electronic zoom unit 17. The electronic zoom unit 17 performs image cut and paste, magnification, and interpolation ~~by~~ using the field memory so that an output image has a magnification factor relative to an input image. The magnification factor being determined by a control signal supplied from the system control unit 21.

The noise reduction unit 18 reduces noise ~~noises~~ in the video signal in response to a control signal supplied from the system control unit 21. The noise reduced video signal is output to a recorder or the like connected to the noise reduction unit 18.

The system control unit 21 controls each component of the image sensing apparatus. As the wide-angle zoom ~~wide~~ key 23 or telephoto zoom key 24 of the zoom operation key unit 22 is depressed, the system control unit 21 also controls the lens drive unit 20 or electronic zoom unit 17 so as to move the zoom lens 11 in the wide-angle ~~wide~~ or telephoto zoom direction.

The system control unit 21 judges, from a lens position detection signal supplied from the lens position detection unit 19, at which position (zoom magnification factor) including

the telephoto end (furthest telephoto end) and wide-angle ~~wide~~ end (widest angle end), the zoom lens is located. A function of magnifying an image picked up with a lens optical system is called an optical zoom, whereas a function of vertically and horizontally magnifying an image by an electronic signal process without using the lens optical system is called an electronic zoom.

The system control unit 21 generally performs ~~the~~ optical zoom by driving the zoom lens 11 in the range of a magnification factor which can be set with the optical zoom. After the zoom lens 11 arrives at the telephoto end (maximum optical telephoto), the image further may be ~~is~~ electronically magnified by ~~the~~ electronic zoom under the control of the electronic zoom unit 17. In this embodiment, the maximum magnification factor of the optical zoom is set to 12 times and the maximum magnification factor of the electronic zoom is set to 4 times, so that ~~the~~ zoom operation with a maximum ~~the high~~ magnification factor of 48 times is possible.

The system control unit 21 outputs a noise reduction control signal to the noise reduction unit 18, the control signal being set differently in the case ~~of that~~ where the optical and electronic zooms are stopped, and in the ~~a~~ case where the optical and electronic ~~of that~~ ~~the~~ zooms are operated, so that the amount of noise reduction can be changed. The noise reduction control signal corresponds to the cyclic coefficient K.

This control signal is also changed in accordance with a change in ~~with~~ the brightness of an object. Ths S/N ratio of a video signal decreases ~~lowers~~ as the brightness of an object becomes darker ~~dark~~. In order to compensate for this, the control signal is changed to make the noise reduction amount larger.

In order to maintain the level of a video signal at a predetermined value even if the amount of input light from an object changes, the system control unit 21 controls the

diaphragm 12, the sample/hold AGC unit 14, an electronic shutter (not shown in Fig. 1) and the like by determining ~~judging~~ the brightness of the object collectively from a diaphragm value, an AGC gain, an electronic shutter speed and the like (hereinafter called exposure control data) used for exposure control.

Next, the optical zoom, electronic zoom and noise reduction controls by the system control unit 21 will be described. Figs. 4 and 5 are flow charts illustrating the noise reduction control process. The program for this process is stored in ROM 32 of the system control unit 21 and executed by CPU 31.

The system control unit 21 determines ~~judges~~ whether the telephoto zoom key 24 is depressed (Step S201). If depressed, the system control unit checks ~~it is checked~~ whether the position of the zoom lens 11 is at the telephoto zoom end (optical zoom magnification factor of 12 times) (Step S203). If the position of the zoom lens 11 is the telephoto end, the zoom lens 11 is fixed to the telephoto end (Step S204).

The system control unit then checks ~~It is then checked~~ whether the electronic zoom magnification factor of the electronic zoom unit 17 is the maximum of 4 times. If 4 times, the electronic zoom magnification factor is fixed to 4 times (Step S206). If not the maximum of 4 times, the electronic zoom unit 17 is controlled so as to increase the magnification factor to a predetermined value (step S207). In this embodiment, although the maximum magnification factor of the optical zoom is set to 12 times and that of the electronic zoom is set to 4 times, other magnification factors may also be set.

If the position of the zoom lens 11 is not the telephoto end at Step S203, the lens drive unit 20 is controlled so as to move the zoom lens 11 in the telephoto zoom direction and increase the magnification factor to a predetermined value (Step S208). The magnification factor of the electronic zoom is fixed to an equal magnification (Step S209).

If the telephoto zoom key 201 is not depressed at Step S201, the system control unit checks ~~it is checked~~ whether the wide-angle zoom ~~wide~~ key 23 is depressed (Step S202). If depressed, the system control unit checks ~~it is checked~~ whether the electronic zoom magnification factor of the electronic zoom unit 17 is the minimum of the equal magnification (Step S212).

If the electronic magnification factor is the minimum of the equal magnification, the electronic zoom unit 17 is controlled so as to fix the electronic zoom magnification factor to the equal magnification. The system control unit then checks ~~It is then checked~~ whether the position of the zoom lens 11 is the wide-angle ~~wide~~ end (optical zoom magnification factor of equal magnification) (Step S214). If the position is the wide-angle ~~wide~~ end, the zoom lens 11 is fixed at ~~to~~ the wide-angle ~~wide~~ end (Step S215).

If the position of the zoom lens 11 is not the wide-angle ~~wide~~ end, the lens drive unit 20 is controlled so as to move the zoom lens 11 in the wide-angle zoom ~~wide~~ direction and reduce the magnification factor to a predetermined value (Step S216).

If the electronic zoom magnification factor is not the equal magnification at Step S212, the electronic zoom unit 17 is controlled so as to reduce the magnification factor of the electronic zoom to a predetermined value (Step S217). The zoom lens 11 is fixed to the telephoto end (Step S218).

If the wide-angle zoom ~~wide~~ key 23 is not depressed at Step S202, the electronic zoom unit 17 is controlled so as to fix the electronic zoom magnification factor without being changed (Step S210). In order to fix the electronic zoom magnification factor of the zoom lens 11, the lens drive unit 20 is controlled so as to stop the zoom lens 11 (Step S211).

Under ~~the~~ conditions where ~~that~~ the electronic zoom unit 17 and zoom lens 11 are stopped, the noise reduction unit 18 is controlled so as to set the noise reduction control mode to a zoom stop mode (Step S219).

Under ~~the~~ conditions where ~~that~~ either the electronic zoom unit 17 or the zoom lens 11 is being operated, the noise reduction unit 18 is controlled so as to set the noise reduction control mode to a zoom operation mode (Step S220). Thereafter, the system control unit 21 temporarily terminates the process, and after it controls each component of the image sensing apparatus, it again repeats the process from Step S201 to Step S220.

As described above, according to this embodiment, it is determined ~~judged~~ whether ~~the~~ a zoom variable magnification operation is being executed. In accordance with this determination ~~judgment~~, the cyclic coefficient of the noise reduction is changed. This method is more effective than the case wherein a motion vector of an image under the variable magnification operation is detected and, in accordance with the detection result, the noise reduction is changed. The reason for this is as follows. Since the mechanism for detecting a motion vector of an image is a feedback loop, there is a delay in changing the noise reduction. Also, the motion vector of an image under ~~the~~ a variable magnification operation diverges so that the motion vector of the overall ~~whole~~ image converges to zero. A proper detection is therefore impossible.

Fig. 6 is a graph showing the relation between the cyclic coefficient K and the brightness of an object in the zoom stop mode and in the zoom operation mode. Steps S219 and S220 are executed in accordance with the graph shown in Fig. 6. The ordinate represents the cyclic coefficient K of the noise reduction. As the cyclic coefficient K changes from "0" to nearer to "1", the noise reduction amount becomes larger and the latent image becomes more conspicuous. As shown in Fig. 6, the cyclic coefficient K of the noise reduction is set

smaller during ~~the~~ zoom operation (zoom operation mode) than during a ~~the~~ zoom stop mode so as to lower the noise reduction amount. The latent image phenomenon can therefore be suppressed. The abscissa represents the brightness of an object which is determined ~~judged~~ from the exposure control data. The brightness of an object is divided into levels or areas A, B, C and D, from the bright ~~brightness~~ side, in accordance with a predetermined reference value.

In the zoom stop mode, the cyclic coefficient K of the noise reduction is "31/32" in the brightest area A of an object. As the brightness of the object changes to the area B, the cyclic coefficient is changed to "63/64". As the area changes to the areas C and D, the value is changed to "127/128" and "255/256", respectively. Similarly, as the area changes from ~~the~~ area D to ~~the~~ area A, the cyclic coefficient is changed from the value "255/256" to the value "31/32".

In the zoom operation mode, the cyclic coefficient K of the noise reduction is "3/4" in the area A. As the area changes to the areas B, C and D, the coefficient changes to the values "7/8", "15/16" and "31/32", respectively, similar to the zoom stop mode.

As above, the cyclic coefficient K of the noise reduction takes the value on a zoom stop mode control line or on a zoom operation mode control line shown in Fig. 6, in accordance with a change in the brightness of an object. The value on the zoom operation mode control line takes a value nearer to "0" than the value on the zoom stop mode control line, at each brightness of an object.

The value of the cyclic coefficient K of the noise reduction may take any value so long as it makes the noise reduction amount of a picked-up image smaller in the zoom operation mode than in the zoom stop mode. The value of the cyclic coefficient K used in this

embodiment is not therefore limited only thereto. So long as the value can change the noise reduction amount, a ~~the~~ control value other than the cyclic coefficient may also be used.

In this embodiment, the cyclic coefficient K of the noise reduction can take the value only on the zoom and the noise reduction control value in the zoom operation mode, intermediate modes Step 1 and Step 2 may be provided between the zoom stop and operation modes, as shown in Fig. 7, so as to use the cyclic coefficients K at Steps 1 and 2 when the mode is being transferred. In this manner, it is possible to suppress the influence, upon images, of switching between ~~the~~ noise reduction control values ~~value~~ during ~~the~~ mode transfer. Fig. 7 is a graph showing the relation between the object brightness and the cyclic coefficient K in the zoom stop and operation modes, and at Steps 1 and 2.

In ~~the~~ optical zoom or electronic zoom operations ~~operation~~ of the present embodiment, a change in the magnification factor per unit time may be increased or decreased so as to stepwise change the zoom speed in accordance with the depression force of the wide-angle zoom ~~wide~~ key or telephoto zoom key. For example, if the zoom speed is increased more as the key is depressed more strongly, the control value K of the noise reduction is gradually lowered in proportion to the zoom speed to thereby suppress the latent image phenomenon. For example, if the zoom speed has three levels, low speed, middle speed and high speed, Step 1 shown in Fig. 7 is used at the low speed, Step 2 is used at the middle speed, and the zoom operation mode control line is used at the high speed, thereby to lower the value K in proportion to the zoom speed. In this manner, influence of the zoom speed upon images can be suppressed by switching the noise reduction control value.

~~Also in~~ In this embodiment, a ~~the~~ zoom lens 11 for optically changing the size of a picked-up image and an ~~the~~ electronic zoom unit 17 for changing the size of a picked-up image through electronic signal processing are used in combination. The present

embodiment, however, also is applicable ~~also~~ to the case wherein either only the zoom lens 11 or the electronic zoom unit 17 is used.

In this embodiment, as shown in Fig. 1, a video signal is processed by the electronic zoom unit 17, for ~~the~~ electronic zoom of an image, and thereafter, the noise reduction unit 18 performs a noise reduction operation. In another embodiment of the present invention, as shown in Fig. 9, an electronic zoom unit 17 may be provided as ~~at~~ the succeeding stage of a noise reduction unit 18.

Figs. 10 and 11 are ~~The~~ flow charts illustrating the operation of an image sensing apparatus having the structure shown in Fig. 9~~, are shown in Figs. 10 and 11~~. In the flow charts shown in Figs. 10 and 11, steps ~~Steps~~ having reference numerals identical to those shown in Figs. 4 and 5 execute ~~they~~ operations similar to those described with reference to Figs. 4 and 5, and the descriptions thereof are omitted here.

At Step S207 shown in Fig. 10, if an image magnification operation is being executed by ~~the~~ electronic zoom, the process flow advances to Step S219 where ~~whereat the~~ noise reduction is switched to the zoom stop mode so as to increase the noise reduction cyclic coefficient K similar to the case in which ~~of that~~ the zoom operation is stopped.

At Step S217 shown in Fig. 11, if an image reduction operation is being executed by the electronic zoom, the zoom lens 11 is stopped at the telephoto end (Step S218) to thereafter follow Step S219, where ~~whereat the~~ noise reduction is switched to the zoom stop mode so as to increase the noise reduction cyclic coefficient K, similar to the case in which ~~of that~~ the zoom operation is stopped.

In this embodiment, while ~~the~~ electronic zoom is executed, even if the cyclic coefficient K of ~~the~~ noise reduction is made large, similar to the coefficient K of the zoom stop mode, the latent image phenomenon will not occur while ~~the~~ electronic zoom is executed

and noise ~~noises~~ can be reduced, because the electronic zoom is executed after ~~the~~ noise reduction of the ~~a~~ video signal.

The present invention also is ~~is also~~ applicable to a system constituted of a plurality of apparatuses ~~apparatus~~ or to a single apparatus. It is obvious that the object of the invention can be achieved by supplying a system or apparatus with a software program. In this case, the system or apparatus reads the program stored in a storage medium to realize the functions and effects of the present invention.

Fig. 8 is a memory map of ROM 32 functioning as such a storage medium. ROM 32 stores a noise reduction control program module realizing the process of the flow charts shown in Figs. 4 and 5, the table values of the cyclic coefficient K shown in the graph of Fig. 6, and the table values of the cyclic coefficient K shown in the graph of Fig. 7.

The storage medium storing the program module is not limited only to a ROM~~,~~; ~~but~~ other media may be used, such as a floppy disk, a hard disk, an optical disk, a magnetooptical disk, a CD-ROM, a CD-R, a DVD, a magnetic tape, and a nonvolatile memory card.

The scope of the present invention also contains the case wherein the functions of each embodiment can be realized by writing ~~the~~ program codes read from the storage medium into a memory of a function expansion board inserted into a computer, or of a function expansion unit connected to the computer, and thereafter by executing a portion or the entirety ~~whole~~ of actual processes by a CPU of the function expansion board or function expansion unit.

As described so far, according to the image sensing apparatus of the above embodiments, the control value of the noise reduction unit is set to a value providing a smaller noise reduction amount in the variable magnification operation mode than in the variable magnification stop mode. Therefore, irrespective of the telephoto or wide-angle

~~wide~~ zoom operation direction, the noise reduction amount is set smaller in the zoom operation mode than in the zoom stop mode, so that the latent image phenomenon ~~to be~~ caused by a change in the size of an object image during the zoom operation mode can be suppressed.

According to the image sensing apparatus of the above embodiments, the control value of the noise reduction is changed with a control value for the exposure adjustment which maintains the level of a generated video signal constant irrespective of the amount of light from an object. It is therefore possible to increase the noise reduction amount so as to compensate for the S/N ratio of a video signal to be degraded by the dark brightness of an object. The present invention ~~is~~ therefore is applicable to provide a larger noise reduction amount of an object at a low brightness more than that of an object at a sufficient brightness.

Many widely different embodiments of the present invention may be constructed without departing from the spirit and scope of the present invention. It should be understood that the present invention is not limited to the specific embodiments described in the specification, except as defined in the appended claims.

ABSTRACT OF THE DISCLOSURE

An image sensing apparatus and method ~~is provided~~ which controls a ~~can sense an image of an object always in good conditions by realizing an optimum~~ noise reduction process ~~even~~ under various photographing conditions and ~~even with~~ various functions of the apparatus, including a ~~apparatus. A~~ system control unit that ~~of the apparatus~~ controls a noise reduction unit by setting the noise reduction control mode to a zoom stop mode under ~~the~~ conditions that an electronic zoom unit and a zoom lens are stopped, and controls the noise reduction unit by setting the noise reduction control mode to a zoom operation mode under ~~that the~~ conditions that either the electronic zoom unit or the zoom lens is operated.

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